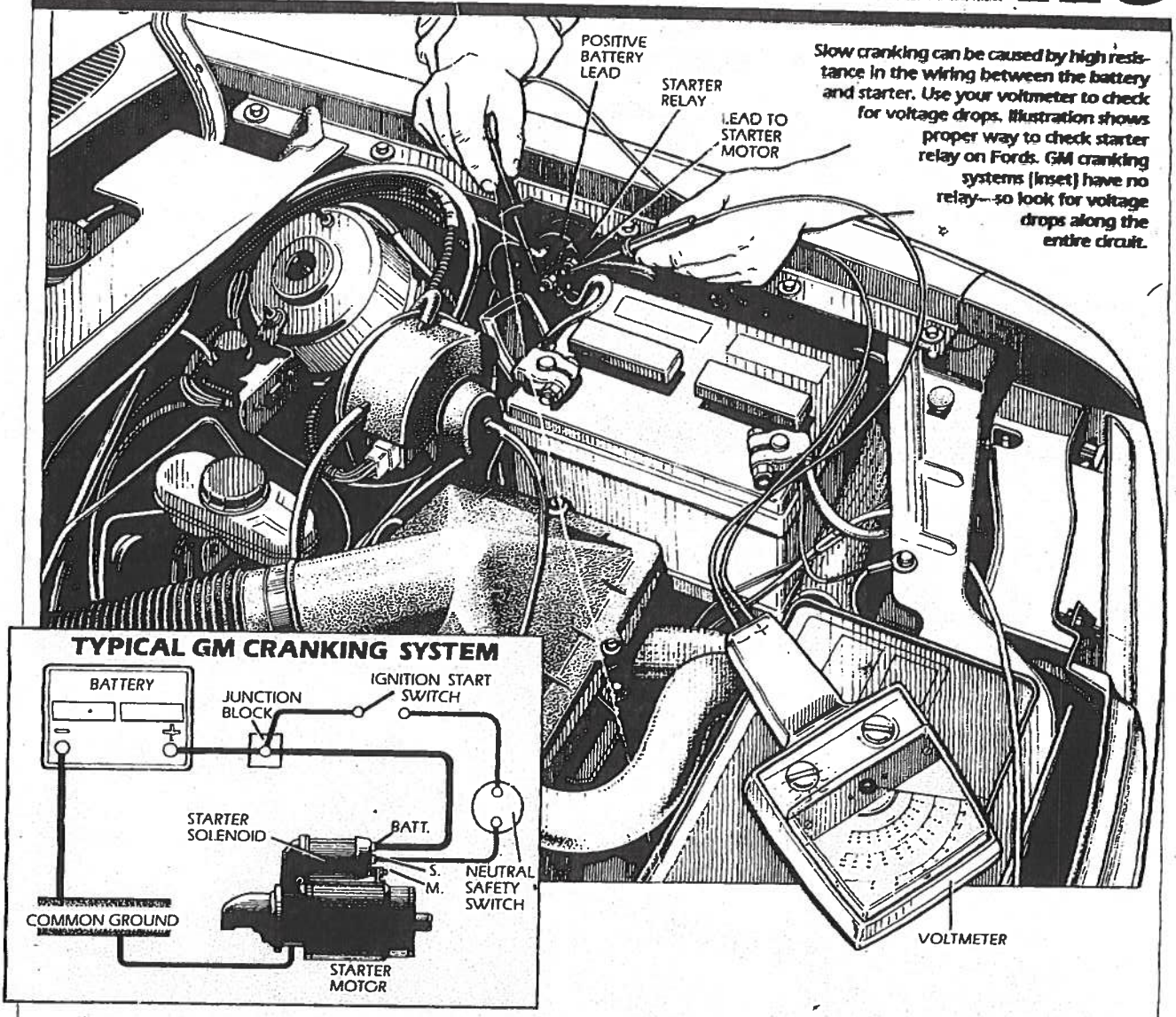
SATURDAY MECHANIC



Slow cranking can be caused by high resistance in the wiring between the battery and starter. Use your voltmeter to check for voltage drops. Illustration shows proper way to check starter relay on Fords. GM cranking systems (inset) have no relay—so look for voltage drops along the entire circuit.

What To Do When Your Car Won't Crank

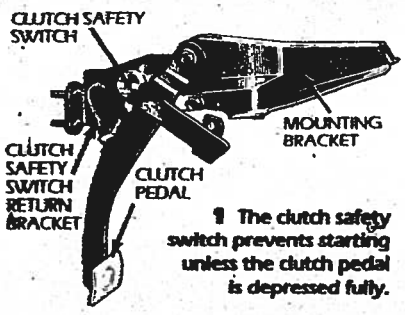
BY PAUL STENQUIST

You hop in behind the wheel, twist the key. Nothing. You try again. Nothing. The battery's probably dead. So, you check battery voltage with your voltmeter and level of charge with your hydrometer or the built-in hydrometer of a maintenance-free battery. The battery has plenty of juice, so you twist the key once more. Dead. It's got to be the cranking system.

What's going on here?

Cranking the engine is the toughest job on the battery. A tremendous amount of current—as much as 300 amps for some engines—is applied to the task of turning the engine fast enough to fire. A heavy cable joins the starter's positive circuit to the battery. Ground is maintained through the engine and battery ground strap and the starter's case.

A second low-amperage circuit is provided for the job of switching the current on and off. It turns the high-amperage starting circuit current on by means of a relay that on some cars is separate from the starter—on others it's on or in the starter. Most GM cars use a solenoid switch mounted either internally or on the outside of the starter motor. Most Fords, AMC and some imports have a



1 The clutch safety switch prevents starting unless the clutch pedal is depressed fully.

relay switch mounted in the engine compartment, usually on a fenderwell. Most Chryslers have both a solenoid switch and relay.

On some cars with solenoids, including all GM, the solenoid not only turns on the cranking current but engages the starter drive pinion with the flywheel. This type is called a solenoid-actuated starter. Cars with relays have a separate device inside the starter to engage the flywheel. On Chryslers with both a solenoid switch within the starter and a relay mounted in the engine compartment, cranking circuit current is turned on and off by the solenoid. Switching circuit current is turned on and off by the relay for a 2-tier switching circuit. The *relay* mounted on the fenderwell is sometimes called a *solenoid*. We'll call it a relay to keep from confusing it with the solenoid mounted on the starter.

When the key is moved to the START position, the low-amperage circuit is closed and current flows to the solenoid or relay—*if the safety switch is in the right position as well.* With an automatic transmission, the safety switch is closed when the selector lever is in NEUTRAL or PARK. With some manual transmissions, the safety switch is closed when the clutch is depressed (Fig. 1). The safety switch can be either of two types. One type completes the positive circuit to allow cranking when the transmission is in the right gear or when the clutch is depressed. The other type completes the ground side of the circuit.

Starting system requirements

Unless several things happen, the engine won't spin when you turn the key.

- The battery has to provide sufficient voltage.
- The key switch has to close the switching circuit between the battery and the solenoid switch or relay.
- The neutral or clutch safety switch has to complete the same circuit.
- The current that flows through this circuit must then close the solenoid switch or relay.
- The solenoid or starter actuator must push the starter motor's pinion gear into engagement with the flywheel ring gear.
- The starter motor must respond to the voltage applied and begin turning.

If a failure occurs in any one of these areas, one of four things may happen.

First, nothing at all occurs.

Second, you hear only a clicking or buzzing noise.

Third, the engine spins but not fast enough to start the car.

Fourth, you hear a whirring noise, but the engine doesn't spin.

In the following sections we'll discuss each type of failure.

Precautions

You want to prevent the car from starting while you're troubleshooting, so disconnect the hot lead to the coil.

Disconnecting the hot lead will also prevent burning up the points by leaving the ignition on while you're tinkering—if your car still has points.

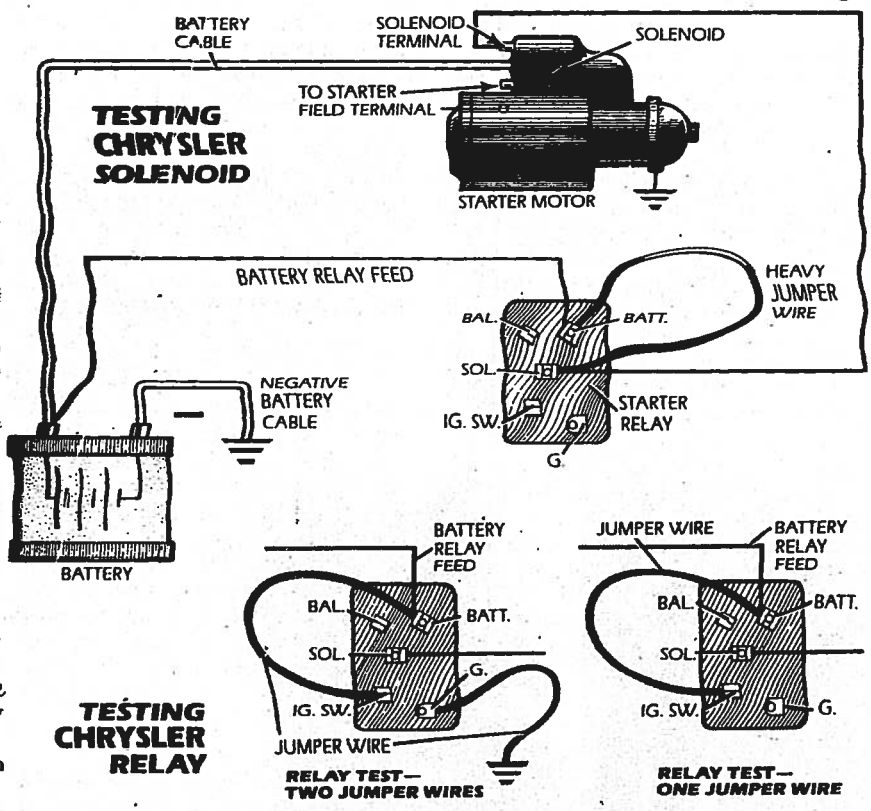
If you have electronic ignition, find out the proper way to disable the ignition, since there's the potential for damage to electronic components if the wrong wire is open or shorted.

Sound of silence

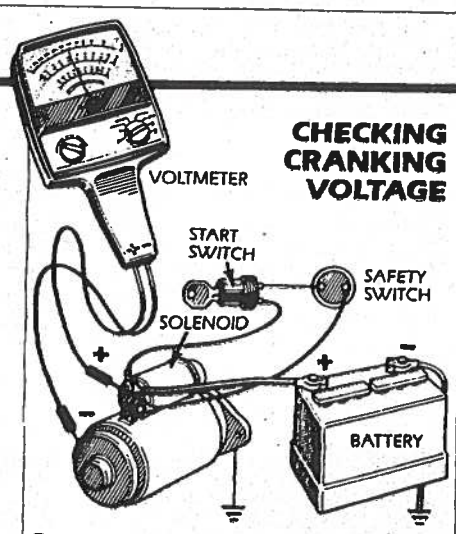
Assuming your battery isn't discharged, "dead silence" can be caused by an open connection in the switching circuit wiring or a bad solenoid or relay. It is usually *not* caused by a bad starter—unless of course both solenoid/relay and starter are defective. When only the starter is shot you usually get a pronounced relay or solenoid "click" when the cranking circuit is switched on.

To determine which part of the switching circuit is at fault on cars with a starter relay and no solenoid switch (including most Ford and AMC), jump the battery and ignition switch terminals of the relay. If the car has a manual transmission, have a helper depress the clutch pedal. If the engine doesn't crank, check to see if the relay has a ground terminal. If it does, leave the first jumper in place and connect a second jumper between the ground terminal and a good chassis ground. If the engine cranks now, the clutch or neutral safety switch is defective or out of adjustment. If the engine still doesn't crank, the starter relay is shot.

If the engine cranked when you installed the first jumper, the no-crank problem is probably caused by voltage



2 *Troubleshoot Chrysler systems by jumping terminals, first bypassing the relay (top), then ignition switch (above right) and finally safety switch (above left).*



3 Use voltmeter on 20-volt range to monitor voltage while cranking engine.

not reaching the relay. On cars with circuit breaker-type safety switches, try installing a jumper around the switch.

If jumping the neutral or clutch safety switch doesn't help, check to see if voltage is reaching the input side of the safety switch with the key in the crank position. If it isn't, there's a problem in the wiring, or your ignition switch is defective. If the warning lights switch on when you turn the ignition key to the RUN position, voltage is reaching the switch, so the problem is either the switch itself or the wiring between the ignition switch and the safety switch.

On Chryslers with both a solenoid and relay, connect a heavy jumper wire on the starter relay between the battery and solenoid terminals (Fig. 2). (On cars with a manual transmission have a helper depress the clutch pedal.) If the engine cranks, the solenoid is good.

Once you're sure the solenoid is okay, check the relay by jumping between the relay's battery and ignition terminals. If the engine cranks, the starter relay is good as well.

If connecting the Chrysler's battery and ignition terminals won't make the engine crank, connect a second jumper on the starter relay between the ground terminal and a good ground. If the engine cranks, the starter relay is good, but the safety switch is defective or misadjusted, the ignition switch is bad or there is a problem in the switching circuit wiring. If the engine still doesn't crank, the relay is probably defective.

On cars with a solenoid switch and no starter relay, including GM, connect the ignition switch or "S" terminal on the solenoid to the battery terminal on the solenoid with a jumper wire. If this causes the engine to crank, the solenoid is not at fault. Check the neutral safety and ignition switches.

Clicking noise

If you heard the solenoid and/or relay click or buzz when you tried to start the engine but the starter didn't turn, the cranking circuit is being switched on, so either the starter is defective or insufficient voltage is reaching it.

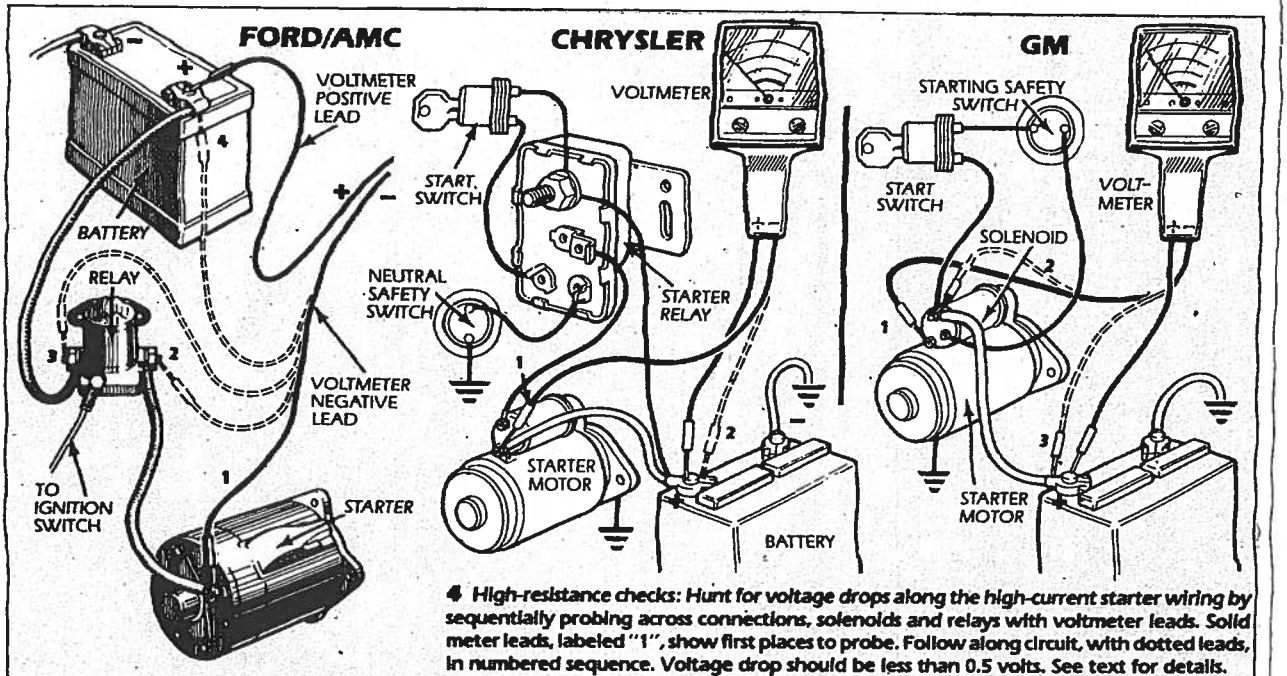
To check cranking voltage, connect the positive lead of your voltmeter to the terminal on the starter where the high-amperage battery cable attaches. Connect the negative lead to the starter housing (Fig. 3). Then crank the engine while you watch the voltmeter. You should see more than 9 volts. If you do and the starter won't turn or turns very slowly, it is probably defective. If you get less than 9 volts and you know for certain that the battery is okay, circuit resistance may be excessive.

Pinpointing high resistance

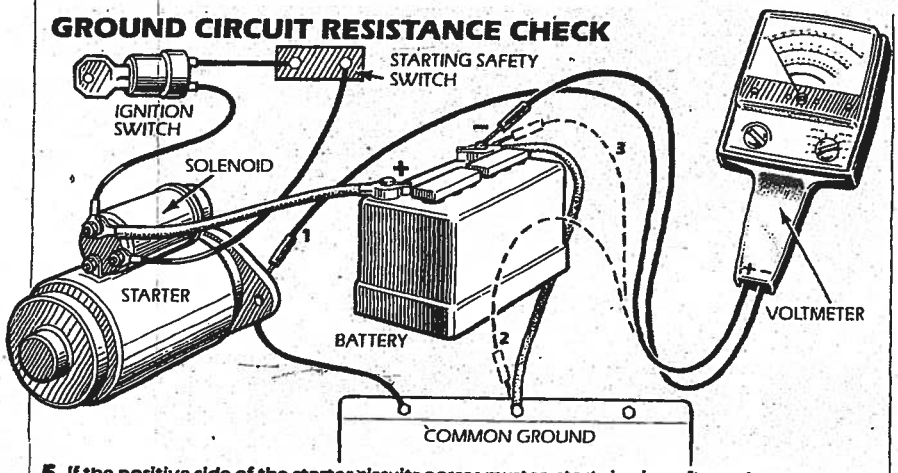
Check the positive circuit first. Connect the positive lead of your voltmeter to the center of your positive battery post—not to the cable terminal. On GM cars, connect the negative lead to the terminal on the solenoid that is joined to the starter motor with a heavy copper strap. You'll find this terminal on the lower part of the solenoid, right above the starter housing. On Chryslers and Fords, connect it to the terminal on the starter or solenoid where the positive battery cable attaches.

Attempt to crank the engine with the voltmeter attached. It should show *less* than 0.5 volt. If it does show less than this figure, high resistance is not the cause. Continue with the negative circuit resistance test below.

If positive circuit resistance is above 0.5 volt, check voltage drop at other locations, each one somewhat closer to the battery. Starting at the positive battery post and starter terminal move successively closer to the battery with the neg-



4 *High-resistance checks: Hunt for voltage drops along the high-current starter wiring by sequentially probing across connections, solenoids and relays with voltmeter leads. Solid meter leads, labeled "1", show first places to probe. Follow along circuit, with dotted leads, in numbered sequence. Voltage drop should be less than 0.5 volts. See text for details.*



5 If the positive side of the starter circuits passes muster, start chasing after voltage drops in the negative, or ground side, with your voltmeter. Voltage drop should be less than 0.3 volts.

ative lead (following the step numbers on Fig. 4). When you reach a point where the drop is acceptable, you know that the defect is between that point and the last location where you tested.

On GM cars, the second place to test is where the battery cable attaches to the solenoid. If voltage drop is within limits here, but was excessive at the first testing point, the solenoid must be replaced. This is a fairly common problem and is a likely cause of either no-crank or slow-crank conditions.

On Fords or AMC cars with a relay in the high-amperage cranking circuit, make your second check at the high-amperage terminal on the starter side of the relay. If voltage drop is okay here, but was excessive at the starter terminal, then either the cable connections are loose or corroded or the cable joining the relay and starter is defective and should be replaced (or perhaps the connections are loose). If voltage drop is still excessive, make your third check at the high-amperage terminal on the battery side of the relay. If voltage drop is within limits at this point, but was excessive on the starter side of the relay, then the relay itself is the source of the high resistance and must be replaced. (See lead illustration on page 137.)

On all vehicles, if you haven't located the cause of the high resistance in previous measurements, make your last voltage-drop check on the battery terminal (voltmeter positive lead on the battery *post*, negative lead on the *terminal*). If the drop is excessive at the terminal, then corrosion or a poor fit between the post and terminal is the problem.

Perform a similar test to check ground circuit resistance, connecting the negative voltmeter lead to the negative battery post and the positive lead to the starter housing (Fig. 5). Attempt to crank the engine and note voltage drop. On most cars it should be less than 0.3 volt. Continue testing at other points in the ground circuit, such as where the ground strap joins the engine to the battery or chassis, the point where the battery ground strap attaches and, finally, at the battery's negative terminal.

If ground circuit voltage drop is less than 0.3 volt and positive circuit drop is less than 0.5 volt, high circuit resistance is not the cause of the cranking problem. In this case, it could be that cranking voltage was low because the engine is tight, or a defective starter.

Slow cranking

An internal engine problem might affect starting when the engine is very hot and pistons are expanded. Some manufacturers provide a torque specification for engine cranking with a torque wrench on the front pulley bolt.

Excessive ignition advance can also cause slow cranking. Sometimes the engine will speed up after a few revolutions. Make sure that timing is set to the carmaker's specification before condemning a starter for slow crank. On cars with a mechanical advance mechanism, make sure the centrifugal weights are not sticking.

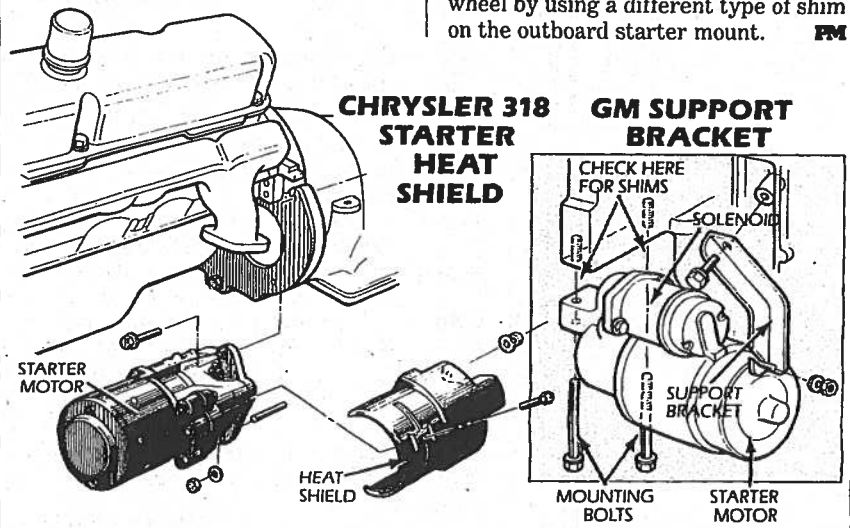
Whirring noise

If you hear the starter motor running when you turn the key to the START position but the engine doesn't crank, the over-running clutch is probably not engaging. This clutch, sometimes called the "Bendix" or starter drive, engages when pressure is applied in one direction. It's designed to prevent the running engine from turning the cranking motor. If the clutch fails to engage, the starter will spin but not turn the engine. Once the starter has been removed from the car, you can check for a faulty clutch by attempting to turn the pinion in both directions. It should turn freely in one direction, but not at all in the other.

Starter replacement

Disconnect the battery's negative ground strap before attempting to remove the starter. Some starters are covered with a heat shield that must be removed for access (Fig. 6). On GM cars, check for shims under the starter mount. These determine pinion-to-flywheel clearance and should be reinstalled with the new or rebuilt starter. There will be instructions for measuring correct clearance, and probably extra shims with your replacement starter.

If there are no shims to remove, the pinion can be moved closer to the flywheel by using a different type of shim on the outboard starter mount. PM



6 Chrysler starter for 318 engine has heat shield that must be removed to replace starter. GM starters (inset) may or may not need to be shimmed when they're replaced.